PLOT STRUCTURE TRANSFORMATIONS IN VERTICALIZED NEIGHBORHOODS OF SANTIAGO METROPOLITAN AREA (CHILE)

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ABSTRACT

This work aims to analyze the evolution of the lot structure of eight verticalized neighborhoods in the Santiago Metropolitan Area (SMA), in order to understand how the verticalization process transforms the geometry and structure of parceling. Residential high-rise developments require parceling adjustments that result in new land use and ownership distribution patterns, reconfiguring the public-private interface. The posed questions are descriptive, as they seek to uncover observable characteristics and processes in the SMA, which may have a more general validity. The sample is composed of eight polygons in which vertical residential developments are concentrated. Maps of lot area and depth-to-frontage ratio before and after the verticalization process were created. Four lot structure transformation typologies are proposed: (1) Homogeneous verticalization and regular transformation of lots, (2) Incomplete verticalization and diversification of lot combination operations, (3) Scattered and intense verticalization, with partial reconfiguration of the lot structure, (4) Scattered verticalization with significant changes in the lot structure. Intensive residential densification developments unleash hugely significant scale changes in the urban fabric that reconfigure the border between public and private, with greater degrees of enclosure between the lot and street.

Key words: Urban morphology, lot structure, verticalization, density, Santiago Metropolitan Area.

INTRODUCTION

Verticalization of urban space triggers radical alterations in the urban form and its components, especially in the organization of plots and buildings (Tella et al 2011, López et al 2015). One of these structural transformations is the reconfiguration of land ownership, which spreads determine new land ownership use and distribution patterns.

The plot is the structure that regulates the transformation of the city, it is essential support for collectively taking on city production (Diez, 1996). Plot configuration has crucial and predictable effects on evolutionary patterns of the urban fabric, as certain forms, surface areas and layouts of plots, blocks and streets are more adaptable amid requirements of urban development Siksna (1998). Incompatibilities between plot area and building form are resolved through the development of new building forms in response to plot restrictions, or by the creation of new plots through combination or subdivision (Siksna, 1997).

Verticalization reconfigures the public-private interface, on some occasions promoting higher degrees of permeability between the sidewalk and private space, and on others greater degrees of enclosure. These new forms of public-private interface can influence the intensity of sidewalk use and its capacity to sustain adequate conditions for walkability (Pafka & Dovey, 2017). For example, small plots limit building heights, producing urban environments on a more intimate scale, bringing buildings closer to the sidewalk (Wood & Dovey, 2018). In addition to responding to real estate dynamics that determine higher or lower levels of transformation, the lot structure reconfigurations associated with verticalization also respond to the structure of the pre-existing urban fabric. Plot configuration patterns significantly influence block structure because they

determine the form of individual buildings, the spaces between them and their collective configuration (Siksna, 1998).

The understanding of the spatial impacts and transformation of the urban fabric caused by verticalization in Latin American cities has recently been addressed by a series of works, which focus on cities such as Buenos Aires (Diez 1996, Tella et. Al. 2011, Vecslir & Kozak 2013), Santiago (Vicuña, 2017, 2020), Concepción (Pérez et.al., 2019) and a series of Brazilian cities (Scussel & Sattler, 2010, De Oliveira et al, 2015, among others). However, these works have not delved into on the impacts of verticalization on lot configuration and its implications on public space.

Scattered verticalization has intensified in the Santiago Metropolitan Area (SMA) since the 1990s, with various degrees of intensity and the densest developments concentrated in more central communes and then expanding toward the pericenter and outskirts of the city. Real estate developments have progressively increased in scale, reaching heights above 30 stories and densities of 12,000 inh/ha.

It is well known that public-private interface plays a critical role in sustaining urban vitality (Gehl 2010, Vialard 2012, Dovey & Symons 2014). As urban densities increase, the relationship between public and private domains becomes critical and efforts to ensure the quality of public space and standards for access to facilities must be intensified (Jacobs & Appleyard 1987). However, in the SMA the lot is increasingly replaced by large-scale, monofunctional developments that reduce ownership, contribute to the physical, social and economic decline of the street (Jacobs 1993, Tarbatt, 2012), and promote monotonous and fragmented urban landscapes, with minimal urban vitality (Wood & Dovey, 2018).

This work aims to analyze the evolution of the lot structure of eight verticalized neighborhoods in the Santiago Metropolitan Area (SMA), in order to understand how the verticalization process transforms the geometry and structure of parceling and its relationship with public space.

METHODOLOGY

The sample is composed of eight neighborhoods located in the center and pericenter of the SMA, with a surface of approximately 25 hectares, and that concentrate vertical residential densification developments. The neighborhoods present different block geometries and areas that structure the urban fabric and differ significantly in terms of the state of advance of the densification process. The lot structure evolution analysis required, first, a survey of parceling in two time periods: initial and current state (2019). The initial state was mapped based on secondary sources and municipal registries that shed as much light as possible on the original parceling. The current state was mapped through interpretation of satellite images and building permits that allowed to corroborate shape and area.

Quantitative description of the plots was based on plot area and depth-to-frontage ratio mapping. The maps shed light on the spatial distribution of predefined ranges and thus the regularity of plot shape and area and the ability of plots to adapt to new building forms and uses. The survey allowed verifying the percentage variation of the number of plots, as well as their distribution in area ranges. In order to identify morphological changes and understand the geometry of lot structure during the verticalization process, the lot depth-to-frontage ratio was mapped according to pre-defined ranges. In turn, we calculated the growth rate of all lots in each of the lot ratio ranges.

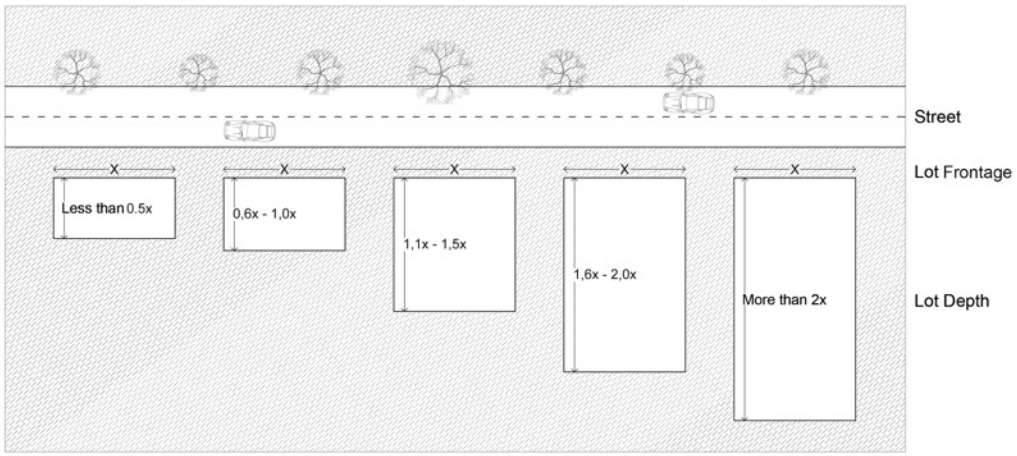

Figure 1. Diagram of lot ratio ranges

FINDINGS

The eight analyzed NEIGHBORHOODS are made up of a total of 1943 plots, which vary significantly in terms of area: while 81% have areas of less than 1000 m^2, 13% have areas between 1001 m^2 and 2500 m2, and 5% between 2501 m^2 and 5000 m^2, while 1% have areas above 5000 m^2. The process of lot structure transformation has taken place at different speeds and to different extents. The net residential densities of these neighborhoods are already high, which, along with recent, more restrictive regulatory modifications, should mean a slowing of the verticalization process.

We observe an increase in lots with areas below 500 m2 (221%) and a slight decrease in those with areas between 501 and 1000 m2 (-3%). Plots with areas between 1001 m2 and 2500 m2 increased by 546% and even larger areas presented significant rates of increase: while those in the 2501-5000-m2 range increased by 141%, plots of more than 5000 m2 increased by 42%.

In terms of geometry (depth-to-frontage ratio), the ranges that presented the greatest increase were those in which the frontage exceeds the depth, that is, the 0.6-1.0 range (669%), followed by the range between 1.1 and 1.5 (102%) and the range of less than 0.5 (99%), in which the frontage is two times greater than the depth. Meanwhile, the only range that has decreased is that greater than 2.0 (-36%), in which the depth is at least twice as long as the depth.

Intensive residential densification developments unleash hugely significant scale changes in the urban fabric that reconfigure the border between public and private space, with greater degrees of enclosure between the lot and street. Each of the analyzed neighborhoods presents significant variations regarding the previously described general transformation trends. While in almost all the cases groups of homes along alleys have been constructed as densification developments with single family housing, the building and parceling transformations have taken place while maintaining the original block structure. Thus, it is possible to identify four categories of lot structure transformation resulting from verticalization processes (Tables 1 and 2).

	Less than 500 m2	501-1000 m2	1001-2500 m2	2501-5000 m2	More than 5000 m2
Homogenous densification through regular plot transformation	-88%	-82%	100%	100%	200%
Incomplete verticalization through diversification of lot combination operations	1643%	-56%	1383%	191%	33%
Scattered and intense verticalization, with partial lot structure reconfiguration	100%	105%	74%	29%	30%
Scattered verticalization with significant changes in lot structure	16%	-40%	-16%	256%	-13%

Table 1. Rate of increase of all lots by area range, between the initial and current states

	Less than 0.5	0.6 - 1.0	1.1 - 1.5	1.6 - 2.0	More than 2
Homogenous densification through regular plot transformation	250%	12%	-75%	-85%	-94%
Incomplete verticalization through diversification of lot combination operations	100%	167%	122%	47%	-47%
Scattered and intense verticalization, with partial lot structure reconfiguration	0%	1425%	59%	6%	26%
Scattered verticalization with significant changes in lot structure	123%	2259%	203%	40%	-54%

Table 2. Rate of increase of all lots according to lot ratio, between the initial and current states

(1) Homogenous densification through regular plot transformation. In this case we found a more advanced densification process and more regular and homogenous verticalization operations. The original regular lot organization pattern, along with a set of regulatory restrictions in sync with the dynamism of the real estate sector, resulted in a relatively consistent urban fabric, especially for high-rise buildings. After almost three decades of transformation, the current lot structure, which also has a regular nature, is the result of a sum of operations combining 5 to 6 lots to build 15-to-20-story residential towers on the resulting lots, with areas of around 2500 m^2.

(2) Incomplete verticalization through diversification of lot combination operations. Presents an incomplete state of the densification process, which has resulted in relative heterogeneity in parceling area and geometry. Although also gradual and continuous over time, the verticalization and densification of these neighborhoods are less advanced than the previous category. The regular geometry prevailed until the 1990s, when the neighborhoods began the process of verticalization and reconfiguration of the urban fabric through lot combination. We observe greater heterogeneity in the distribution of lot areas and particularly geometry. For example, in one of the neighborhoods, along with lot combination operations, we also observe taller (5-7-story) densification developments on just one original lot, as well as original buildings still used for residential purposes or which have been converted into offices.

These developments have led to significant heterogeneity in lot area and geometry; an important percentage of lots have not been part of the verticalization process. We observe an increase in lots in the ranges of 1001-2500 m2 (1383%) and less than 500 m2 (1643%), as well as a decrease in the range of 501-1000 m2 (-56%). Thus, the lot density of the neighborhood has decreased by 10%. Residential high-rises coexist with buildings of one or two stories, some of which still have

residential uses. There are other original buildings that are now used for commerce, services and education.

(3) Scattered and intense verticalization, with partial lot structure reconfiguration. This category applies to the neighborhoods of the southern and western pericenter of the SMA that present a highly heterogenous pre-existing lot structure; that is, there are lots with different areas, geometries and uses. These neighborhoods present a densification process that, although incipient, is very intense in terms of the heights and densities reached by the new buildings (Vicuña, 2017). We observ a prior processes of residential densification through the construction of single family homes along alleys. The blocks, with large areas, required these developments early to increase the available lot frontage. Therefore, the lot density increased by 63% between the initial and current state.

Unlike neighborhoods of a mostly residential nature, the verticalization process has not taken place through lot combination, but rather through subdivision and use of lots with larger areas with obsolete or low-value uses. The residential densification process has transformed the pre-existing building structure by intensifying height and buildability, while also partially altering the lot configuration. The availability of large sections of land has spurred developments on a completely different scale relative to those observed in other neighborhoods in the sample, with blocks of 2 to 4 high-rises that house up to 1000 apartments.

(4) Scattered verticalization with significant changes in lot structure. This category corresponds to neighborhoods in the historical center of the city that present recent processes of very intense verticalization involving significant changes in parceling. These neighborhoods are located south of Bernado O´Higgins Ave., the border of the city at the time of its foundation. They originally consisted of small farms that were developed as long blocks, with streets that continued the original layout toward the south, following the direction of the irrigation canals. In the first state of development analyzed (1910), which corresponds to an initial phase of densification, the rectangular blocks (100 meters by up to 380 meters) were subdivided mainly into lots with narrow frontages and long depths, which faced north-south streets. Despite the significant density of the lots in this first phase of development, predominates the lot depth-to-frontage ratio of over 2. However, the range with more increment is tn 0.6-1.0.

The current lot configurations differ substantially from the original ones. Lot density has changed with a highly heterogeneous structure that is a result of a series of redevelopment operations and lot combination and subdivision over the last century. Therefore, on one block plots of 150 m2, on which houses, small businesses or workshops stand, may exist alongside plots of approximately 3500 m2, on which residential high-rises are located. As in the previous category, verticalization projects prioritize the combination of larger plots, between 600 m2 and 900 m2. Given the configuration of the Bulnes neighborhood, the lot combinations occur more frequently between rectangular lots; although this lot geometry is maintained, the frontage increases considerably.

CONCLUSIONS

The categories of lot structure transformation, according to Dovey & Wood (2018), are schematic explanations that allow the city to be interpreted, disaggregating its complexity through the language of form. The results presented here, more than evidencing categorical truths, reveal a spatial dimension of verticalization that has been practically unexplored in Latin American cities. Although verticalization tends to occur in relatively irregular patterns according to the degree to which local regulations influence market dynamics, the morphological pattern of the original lot layout plays a fundamental role in the transformation of the urban fabric.

The residential high-rise, an architectural model of quick construction and sale, is the main mechanism of urban renewal in the SMA. The standardized high-rise produces significant negative externalities for urban habitability and heritage. It introduces exogenous typological elements such as the front yard and tower in historical neighborhoods with continuous facades.

The performance of the urban form can be assessed in terms of flexibility according to its capacity to admit land-use changes and in terms of stability according to its capacity to respond to the connectivity and intelligibility of a city as a whole (Vialard, 2012). Thus, to drive quality verticalization processes not only are height, buildability and grouping restrictions important; in addition, regulatory parameters of lot frontage and subdivision also take on importance. Chilean regulations stipulate only a minimum lot subdivision.

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